

REMARKS

Claims 1 to 7, 9 to 11 and 26 are pending in this application.

The Rejection under Prior Art

Claims 1 to 7 and 9 to 11 are rejected under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 5,780,701 ("Kaska et al.") in view of U.S. Patent No. 6,358,486 ("Shan et al.") and further in view of either the Abramson et al. Article or U.S. Pub. No 2001/0053832 ("Watanabe"). Kaska et al. is directed to a process for alkane group dehydrogenation with an organometallic catalyst. Shan et al. discloses a mesoporous material. Abramson et al. is directed to the design of beta-aminoalcohols for enantioselective addition of diethylzinc to benzaldehyde and Watanabe is directed to a catalyst and process for olefin polymerization.

It is respectfully submitted that none of the cited references, whether taken individually or in combination, discloses or suggests the claimed invention.

Claim 1 recites that the pincer complex is bonded to the inorganic oxide support by means of a bridging group. The bridging compound is a significant feature because it creates a heterogenized composition. In other words, the present invention is an immobilized catalyst because it is embedded with the binder via the bridging compound by chemical bonding. Heterogenized catalysts have significant advantages over traditional, homogeneous (i.e., catalyst which is in the same phase as the reactant) catalysts. A primary advantage is that the heterogenized catalyst does not require catalyst/reaction effluent separation or catalyst recovery. In this invention, the active moiety in the catalyst is covalently bonded to the catalyst support (i.e., the mesoporous material). It will not suffer from leaching into the reactant stream itself.

Leaching results in the loss or dilution of the catalyst, thereby reducing its efficacy. Furthermore, leached catalyst must be recovered or its loss in the effluent stream must be remedied by continuous addition of catalyst make-up. Either way, significant extra costs are incurred. Therefore, the heterogenized catalyst of the invention is much more efficient and less expensive than a homogenous catalyst.

The Examiner takes the position that it would be obvious to bind the homogeneous catalysts disclosed in Kaska et al. on a support material with a bridging group. However, what typically happens in the heterogenizing of homogeneous catalysts onto porous supports is the adsorption or impregnation facilitated by the bridging group. In contrast, the catalyst of the invention consists of three parts which are bonded together to provide a new entity: the support, bridging molecule and the organometallic pincer complex. None of the cited references, whether taken individually or in combination, discloses or suggests the invention claimed herein. Neither do the cited references provide any expectation of successfully creating the catalyst of the invention, as opposed to an adsorbed or impregnated catalyst.

The Kaska et al. patent discloses a homogeneous phase catalyst for alkane group dehydrogenation which is not bonded to an inorganic oxide support. In the dehydrogenation processes exemplified in Kaska et al. (see, Examples at columns 11 and 12) the reactants were heated over a period of time in sealed tubes under argon. Leaching of catalyst was not an issue of any consideration. There is no suggestion in Kaska et al. that the catalyst be incorporated into a heterogeneous support.

Shan et al. states that "... it is also possible to attach (graft) functional components on the wall by reaction of surface hydroxyl groups with the compound in the gas or liquid phase." (Col. 7, lines 39-42). However, Shan et al. does not say anything about the heterogenizing of homogeneous catalysts. Shan et al. mentions nothing about pincer complexes. Nor does Shan et al. suggest the covalent bonding of pincer complexes by means of a bridging molecule.

Abramson et al. is directed to heterogenized beta-aminoalcohols for enantioselective addition of diethylzinc to benzaldehyde. This reaction involves different chemistry from that of Applicants' invention and is in a different field of art. One skilled in the art would find no motivation to covalently bond a pincer complex to a mesoporous support via a bridging molecule to provide a catalyst for the dehydrogenation of alkanes to alkenes, as contemplated by Applicants' invention.

Watanabe [¶0063] discloses the use of a bridging group to bond Cp to X^1 in the formulas $CpMX^1_3$ and $(CpMX^1_m)_2X^{2}_{3-m}$. However, Watanabe does not disclose bonding a dehydrogenation catalyst to an inorganic oxide support by means of a bridging group. Rather, Watanabe's process is for polymerization in a homogeneous liquid phase whereas the claimed catalyst is a solid catalyst for dehydrogenation suitable for packing into a catalytic distillation column. There is no support for concluding that the teachings of Watanabe can be successfully combined with Kaska et al. to provide a workable result.

The cited references are in different fields of art with different technical requirements. For example, the heterogenized catalyst of the invention allows for a different reaction scheme, as shown in the Fig. 1 of the present application. This is different from the homogeneous catalyst

reaction scheme, wherein the soluble catalyst flows along with reactor effluent. As is known in the art, conversion of alkanes to alkene is an equilibrium reaction and is thermodynamically unfavored at low temperature. A way to make this more favorable is to remove one or more of the reaction products right away to favor the product formation. This is not possible in a traditional homogenous catalyst vessel scheme.

However, the present invention allows the separation of reaction products in the catalytic distillation reactor 10. This provides reaction thermodynamics favoring an enhanced conversion of the reactant. Furthermore, the mesoporous material used and the reaction scheme lead to an overall increase in available catalyst surface area and an increase in catalyst dispersion (as compared to the homogeneous scheme). The result is a simultaneous improvement in both reaction kinetics and thermodynamic reaction conditions. None of the cited references achieves or suggests the advantages of Applicants' claimed invention.

More particularly now, claim 6 is amended to recite group G as a required component of the catalyst formula. Kaska et al. does not disclose or suggest an equivalent to this component. Claim 9 is amended to recite that the bridging group establishes chemical bonding of the inorganic oxide support to the pincer complex by chemical reaction with the inorganic oxide support and with G. This feature is neither disclosed nor suggested by the prior art. Claims 6 and 9 are even further patentable over the cited references. Accordingly, all of the pending claims are submitted to be allowable over the cited prior art. Reconsideration and withdrawal of the rejection are respectfully requested.

The New Claim

New independent claim 24 is added herein and is submitted to be allowable over the prior art references for substantially the reasons given above.

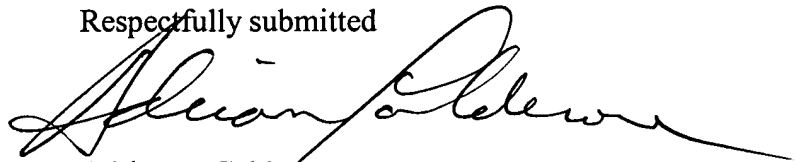
Other Matters

The Declaration was deemed to be defective because of a non-initialled, non-dated alteration. Preparation and submission of a new Declaration will be considered.

CONCLUSION

For at least the reasons stated above all of the pending claims are submitted to be in condition for allowance, the same being respectfully requested.

Respectfully submitted

A handwritten signature in black ink, appearing to read 'Adrian T. Calderone', written in a cursive style.

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